THE
AMERICAN JOURNAL
OF THE MEDICAL SCIENCES
JULY, 1919

ORIGINAL ARTICLES

THE MANAGEMENT OF POSTPNEUMONIC EMPYEMA BASED UPON 310 CASES.

BY WILLARD J. STONE, M.D., MAJOR, M.C., U.S.A.,
TOLEDO, OHIO;
CHIEF OF MEDICAL SERVICE, U. S. A. BASE HOSPITAL, FORT RILEY, KANSAS.

AMONG approximately 4000 patients with pneumonia, empyema necessitating repeated aspirations or operation has occurred in 310. The actual incidence of empyema in pneumonia has, however, been higher in this locality than these figures indicate. In many patients with a rapidly spreading pneumonia leading to a fatal outcome in three or four days, empyema was diagnosed prior to death. The advisability of operation upon these patients was not considered, nor have they been included in this report. During the epidemic of measles and pneumonia at the Fort Riley Reservation, which occurred in the fall and winter of 1917–1918, during the epidemic of streptococcus pneumonia which occurred during March and April, 1918, as well as during the epidemic of influenzal pneumonia, September 15 to November 1, 1918, a sufficient amount of purulent fluid in the thorax to warrant the use of the term, empyema, could be determined prior to death in many patients. In fact, exudation of serous and later of seropurulent fluid, in greater or lesser amount, into the pleural cavities took place so frequently in these extensive epidemic pneumonias that its occurrence might be considered almost the rule rather than the exception. In many such patients death occurred so rapidly that the presence of fluid was looked upon as an incident rather than the determining factor in producing death.

Depending upon the locality, the etiological factors producing pneumonia may be expected to show variation. From experience in army base hospitals, two facts of importance have been rather universally recognized. The first fact refers to the general prevalence of the streptococcus (normally one of the hemolytic varieties) in pneumonia following measles. The second fact refers to the prevalence of the streptococcus, likewise one of the hemolytic varieties, as an organism associated in many localities with the pneumococcus in the production of epidemic pneumonia not preceded by measles or influenza, but as a distinct type in which the pneumococcus has appeared to play but a minor role. In certain localities, during the recent epidemic of influenzal pneumonia, the pneumococcus was the prevalent type of infection both in the acute disease and in the subsequent empyemas. In other localities the pneumococcus and streptococcus have been associated, while in others streptococcus pneumonias have been more frequently encountered than had been heretofore generally recognized.

In the series of empyema here reported only those are included which required treatment by aspiration or operation. There were available for this report 35 empyema patients who recovered by repeated aspirations alone, while 275 came to operation. Those patients were not included who died within a few days of admission with an established diagnosis of empyema or those who died during the course of aspirations designed for their relief, but who, because of activity of the pneumonic process, acute bilateral empyema, purulent pericarditis, meningitis or other serious complications, were not considered reasonable operative risks.

Because of the interest attached to variations of treatment, with increasing experience, these empyema patients have been grouped, depending largely upon three-time intervals, as follows:

1. First series: Early operation (October 20, 1917, to January 21, 1918), 85 cases. Mortality, 61.2 per cent.
2. Second series: Early aspirations and late operation (January 12, 1918, to August 10, 1918), 96 cases. Mortality, 15.6 per cent.
3. Third series: Early aspirations and late operation (October 18, 1918, to February 14, 1919), 94 cases. Mortality, 9.5 per cent.

The three series of operated empyemas are comparable as to number. Each series represents as accurately as possible, but with some overlapping, different types of preceding pneumonia. The series are also comparable as to type of infection.

First Series, Early Operation. This series of 85 patients occurred during the measles epidemic which affected the 89th and 92d Divisions of the Army, stationed at Camp Funston. The epidemic began about October 18, 1917, and reached its crest during the week ending December 28, 1917, gradually declining to February 15, 1918, after which to May 18 the disease existed in sporadic form with each new influx of recruits. During this period about 3000 patients with measles were admitted to the base hospital. During October but 1 empyema operation was performed; during November, 24; during December, 42; from January 1 to January 21, 1918, 18. These patients were operated upon as soon as the diagnosis of empyema was made and are therefore described under the heading of early operation. The following tables bring out the important facts relative to the mortality:

TABLE I.—SERIES I, EARLY EMPYEMA OPERATIONS, OCTOBER 20, 1917, TO JANUARY 21, 1918.

	Total operations.	Deaths.	Mortality, per cent.
October, 1917	1	1	100.0
November	24	15	62.5
December	42	27	64.3
January, 1918	18	9	50.0
Total	85	52	61.2

TABLE II.—TYPE OF OPERATION.

	Number.	Deaths.	Mortality, per cent.
Costectomy	50	28	56.0
Thoracotomy	32	21	65.6
Unrecorded	3	3	
	85	52	
Costectomy, right	32	14	43.7
Thoracotomy, right	18	12	66.6
Costectomy, left	18	14	77.7
Thoracotomy, left	14	9	64.3
	82	49	
Unrecorded	3	3	
	85	52	61.2

TABLE III.—ANESTHESIA.

	Number.	Deaths.	Mortality, per cent.
Local	71	43	60.5
General	11	6	54.5

TABLE IV.—TYPE OF PNEUMONIA PRECEDING EMPYEMA.

	Number.	Deaths.	Mortality, per cent.
Lobar pneumonia	46	25	54.3
Measles pneumonia[1]	39	27	69.2
Total	85	52	61.2

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[1] The term measles pneumonia includes lobar and bronchopneumonia following measles. It was difficult clinically to distinguish the type in many patients. In a series of 46 necropsies upon measles-pneumonia patients, lobar pneumonia was found in 41 per cent. and bronchopneumonia in 54 per cent.

TABLE V.—TYPE OF INFECTION IN EMPYEMA FLUIDS.

	Strept. hem.	Strept. non-hem.	Pneumo.	No record or growth.
Lobar pneumonia empyema, recovered	6	4	8	3
Lobar pneumonia empyema, death	7	7	7	4
	13	11	15	7
Measles pneumonia empyema, recovered	3	6	1	2
Measles pneumonia empyema, deaths	9	10	3	5
	12	16	4	7

TABLE VI.—PER CENT. RECOVERIES AND DEATHS AS TO TYPES OF PNEUMONIA AND INFECTION.

	Number.	Strept., per cent.	Pneumo., per cent.
Lobar pneumonia empyema, recovered	18	25.6	20.5
Lobar pneumonia empyema, death	21	35.9	17.9
	39	61.5	38.4
Measles pneumonia empyema, recovered	10	28.1	3.1
Measles pneumonia empyema, death	22	59.3	9.4
	32	87.4	12.5

TABLE VII.—EMPYEMA RECOVERIES AND DEATHS AS TO TYPES OF INFECTION.

	Number.	Recovered, per cent.	Deaths, per cent.
Streptococcus	52	36.5	63.3
Pneumococcus	19	47.4	52.6
	71		

DISCUSSION. The fact was not well recognized at the time of operation upon these patients that pleuritis almost universally accompanied a rapidly spreading pneumonia following measles and that seropurulent or serosanguineous fluid containing streptococci (usually one of the hemolytic varieties) was to be expected in approximately 75 per cent. of those patients who were to succumb whether the chest was drained or not. Costectomy or thoracotomy did not necessarily entail the danger of lung collapse, for in many of them the lung on the affected side was found to be collapsed from pressure of fluid at the time of operation or verification of such condition was obtained at necropsy in the non-operated patients. The danger of an open pneumothorax when associated with an active pneumonic process and diminished alveolar air space was not appreciated at this time. The lungs usually in such cases presented the picture of diffusely scattered areas of peribronchial pneumonia

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[1] Including streptococcus types not differentiated.

(so-called interstitial pneumonia). Operation was done in the hope of affording relief to patients literally drowning in their own septic fluids. That the procedure was not without hope was borne out by the fact that 38.8 per cent. of 85 patients so operated recovered. The high mortality in December, 1917, of 64.3 per cent., soon led to the conclusion that the drainage operation and open pneumothorax carried with it great danger to the patient with an active pneumonic process, and that while the operation carried with it the element of possible benefit to approximately 38 per cent. of the patients, there was great probability that death was hastened in the remaining 62 per cent. It was believed, in other words, that many of these patients were not reasonable operative risks and that many would die irrespective of the treatment employed, since 17, or 33 per cent., died within seventy-two hours from the time the open pneumothorax was secured.

With this end in view the attempt was made, about January 12, 1918, to repeatedly aspirate, in closed circuit by the Potain aspirator, fluids from the chest as soon as diagnosed in active pneumonias. Such aspiration, depending upon the character and amount of fluid was performed every day or alternate day until such time as it was believed the activity of the pneumonic process had subsided. It soon became evident that a considerable number of patients who appeared fatally stricken were relieved by the aspirations. It also was evident among those who died that the end was not hastened, but was in many instances delayed because of the aspirations.

Second Series (Late Operation). The first operation under this repeated aspiration plan was performed January 29, 1918. Upon this patient a total of nine aspirations had been performed during an interval of seventeen days subsequent to the diagnosis of empyema. Between January 29 and August 10, 1918, 96 patients with empyema were operated, following this plan of procedure. Daily irrigation of the empyema cavity with neutral solution of chlorinated soda was used in these patients. There were 15 deaths, a mortality of 15.6 per cent. Most of the patients in this group developed empyema following lobar pneumonia, but the streptococcus, as in the measles epidemic, continued to be the most frequent infection in the empyema fluids. During the first series of empyema operations the streptococcus was isolated in 52 of 71 operated empyemas, or 73.2 per cent. During the second series the streptococcus was isolated in 70 of 95 operated empyemas, or 73.6 per cent. Many of the patients of this second series developed empyema following streptococcus lobar pneumonia, which occurred in severe epidemic form during March and April, 1918. The mortality by months is shown in Table 8.

TABLE VIII.—SERIES II, LATE EMPYEMA OPERATIONS, JANUARY 29, TO AUGUST 10, 1918.

	Total operations.	Deaths.	Mortality, per cent.
January, 1918	2	0	0
February	14	2	14.3
March	9	3	33.3
April	44	7	15.9
May	15	2	13.3
June	8	1	12.5
July	3	0	0
August	1	0	0
	96	15	15.6

TABLE IX.—TYPE OF OPERATION.

	Number.	Deaths.	Mortality, per cent.
Costectomy	78	14	17.9
Thoracotomy	18	1	5.5
	96	15	15.6
Costectomy, right	36	5	13.9
Thoracotomy, right	8	1	12.5
Costectomy, left	42	9	21.4
Thoracotomy, left	10	0	0.0
	96	15	15.6

TABLE X.—ANESTHESIA.

	Number.	Deaths.	Mortality, per cent.
Local	68	12	17.6
General	28	3	10.7
	96	15	15.6

TABLE XI.—TYPE OF PNEUMONIA PRECEDING THE EMPYEMA.

	Number.	Deaths.	Mortality, per cent.
Lobar pneumonia	90	14	15.5
Measles pneumonia	6	1	16.6
	96	15	15.6

TABLE XII.—TYPE OF INFECTION IN EMPYEMA FLUIDS.

	Strept., hem. per cent.	Strept., non-hem. per cent.	Pneumo. per cent.	Strept and pneumo. per cent.	No record.
Lobar pneumonia empyema:					
Recovered	33	20	20	2	1
Death	8	3	3	0	0
	41	23	23	2	1
Measles pneumonia empyema:					
Recovered	3	1	1	0	0
Death	1	0	0	0	0
	4	1	1	0	0

TABLE XIII.—PERCENTAGE OF RECOVERIES AND DEATHS AS TO TYPE OF PNEUMONIA AND INFECTION.

	Number.	Strept., hem., per cent.	Strept., non-hem., per cent.	Pneumo., per cent.	Pneumo. and strept. per cent.
Lobar pneumonia empyema:					
Recovered	75	37.1	22.4	22.4	2.2
Death	14	9.0	3.4	3.4	0.0
	89	46.1	25.8	25.8	2.2
Measles pneumonia empyema:					
Recovered	5	50.0	16.6	16.6	0.0
Death	1	16.6	0.0	0.0	0.0
	6	66.6	16.6	16.6	0.0

TABLE XIV.—EMPYEMA RECOVERIES AND DEATHS AS TO TYPES OF INFECTION.

	Number.	Recovered, per cent.	Deaths, per cent.
Streptococcus	69	82.6[3]	17.4[4]
Pneumococcus	24	87.5	12.5
Mixed infection (streptococcus and pneumococcus)	2	100.0	
	95		

Table 15 shows the average number of aspirations performed and the average number of days before operation in the 96 patients with empyema constituting the second series.

TABLE XV.—NUMBER OF ASPIRATIONS AND DAYS BEFORE OPERATION.

	Number.	Average number of aspirations before operation.	Average number of days before operation.
Recovery	81	6[5]	19[6]
Death	15[7]	6	21

Series III (Late Empyema Operations). The third series of empyema followed pneumonia incident to the epidemic of influenza during the autumn of 1918. Between October 18, 1918, and February 14, 1919, 94 patients required operation. Of these 9 have died to April 8, 1919; 73 have recovered; 10 are still in hospital with prognosis favorable; while 2 patients have an unfavorable prognosis, due to tuberculosis with large pyopneumothorax in each.

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[3] Among the recoveries, three patients had post-scarlet fever pneumonia, empyema (Streptococcus hemolyticus) and nephritis. Two patients subsequent to lobar pneumonia and the healing of their empyemas were found to have active pulmonary tuberculosis. One patient had lobar pneumonia with empyema which was operated, followed by pneumonia on the opposite side with pleural effusion which was relieved by aspiration and eventual recovery.

[4] Four deaths occurred from nephritis in post-scarlet fever pneumonia and empyema. One death occurred from streptococcus endocarditis and nephritis following post-scarlet fever lobar pneumonia and empyema.

[5] Not including one patient who had bilateral empyema with four distinct pockets; a total of 68 aspirations were performed before costectomy, followed by recovery.

[6] Not including two patients from whom operation was delayed for an unusually long period because of their critical condition due to nephritis. Both recovered.

[7] Four of the fifteen deaths resulted from post-scarlet fever nephritis. One death resulted from post-scarlet fever endocarditis and nephritis.

TABLE XVI.—TYPE OF OPERATION.

	Number.	Deaths.	Mortality, per cent.[8]
Costectomy	88	7	7.9
Thoracotomy	6	2	33.3
	94	9	9.5

TABLE XVII.—ANESTHESIA.

	Number.	Deaths.	Mortality, per cent.[9]
Local	91	9	9.8
General	3	0	0.0
	94	9	9.5

TABLE XVIII.—TYPE OF PNEUMONIA PRECEDING THE EMPYEMA.

	Number.	Deaths.	Mortality, per cent.[10]
Influenzal pneumonia[11]	41	2	4.9
Lobar pneumonia	30	5	16.6
Measles pneumonia	17	1	5.9
Bronchopneumonia	6	1	16.6
	94	9	9.5

TABLE XIX.—TYPE OF INFECTION IN EMPYEMA FLUIDS.

	Number.	Per cent.
Streptococcus hemolyticus	53	62.3
Streptococcus, non-hemolytic	6	7.0
Pneumococcus	25	29.4
Streptococcus viridans and pneumococcus	1	1.1
	85	
No record or contamination	9	
	94	

TABLE XX.—EMPYEMA RECOVERIES AND DEATHS AS TO TYPE OF INFECTION.

	Number.	Recovered, per cent.	Deaths, per cent.[12]
Streptococcus	59	93.3	6.7
Pneumococcus	25	84.0	16.0
Mixed infection (streptococcus and pneumococcus)	1	100.0	

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[8] To April 8, 1919. [9] To April 8, 1919. [10] To April 8, 1919.

[11] During the epidemic of influenza, the pneumonia was of lobar type in 72.6 per cent. of 55 patients upon whom necropsy was performed.

[12] To April 8, 1919.

Table 21 shows the average number of aspirations performed and the average number of days before operation in the ninety-four empyema patients of the third series.

TABLE XXI.—NUMBER OF ASPIRATIONS AND DAYS BEFORE OPERATION.

Number.	Average number of aspirations before operation.	Average number of days before operation.
94	3.7	13.5

DISCUSSION OF TYPES OF INFECTION IN THE THREE SERIES. In Table 22 the percentage of cultures positive for streptococcus and pneumococcus in the three series of operations have been arranged for purposes of comparison. It will be observed in each series that the streptococcus (usually one of the hemolytic varieties) has been the type of infection responsible for the condition in approximately 70 per cent. of the patients.

TABLE XXII.—COMPARISON OF TYPES OF INFECTION IN THREE SERIES OF EMPYEMA.

	Number.	Strept., per cent.	Pneumo., per cent.
First series	71	73.2	26.7
Second series	95	73.6	26.3
Third series	85	70.4	29.4

For purpose of comparison as influenced by the radically different treatment in the first as compared with the second and third series the following table is given. It will be observed that in the first series, when early operation was done, the percentage of recoveries in streptococcus empyema was 36.5, while in the second and third series, when late operation was done, the percentage of recoveries in streptococcus empyema was 82.6 and 93.3 respectively. In the first series the percentage of recoveries in pneumococcus empyema was 47.4, while in the second and third series the percentage of recoveries in pneumococcus empyemas was 87.5 and 84 respectively.

TABLE XXIII.—COMPARATIVE RECOVERIES AS TO TYPE OF INFECTION IN THREE SERIES OF EMPYEMA.

	Number.	Strept. recoveries, per cent.	Pneumo. recoveries., per cent.
First series	71	36.5	47.4
Second series	95	82.6	87.5
Third series	85	93.3	84.0

NECROPSY FINDINGS. Necropsies were performed upon forty-eight patients who died subsequent to empyema operations. Abstracts of the clinical diagnoses and the necropsy findings have been arranged in sequence for the three series of operations.

FIRST SERIES EMPYEMA, NECROPSY ABSTRACTS.[13]

No. 9, 1917. Clinical Diagnosis: Pneumonia, lobar left; empyema, operated left.

Anatomical Diagnosis: Pneumonia, lobar left lower; empyema, left; pleurisy, fibrinous right.

No. 11, 1917. Clinical Diagnosis: Pneumonia, lobar right lower; empyema, operated right.

Anatomical Diagnosis: Pneumonia, lobar right with abscess formation; empyema, right; pericarditis, purulent acute; endocarditis (mitral and aortic), acute.

No. 24, 1917. Clinical Diagnosis: Measles; pneumonia, broncho-bilateral; empyema, operated right.

Anatomical Diagnosis: Pneumonia, lobar with cavity formation right; empyema, right; pleuritis, fibrinopurulent right.

No. 26, 1917. Clinical Diagnosis: Measles; pneumonia, broncho, right; empyema, operated right.

Anatomical Diagnosis: Empyema, right; peritonitis, plastic with adhesions between diaphragm and liver.

No. 27, 1917. Clinical Diagnosis: Pneumonia, postoperative broncho, right, following appendectomy; empyema operated right.

Anatomical Diagnosis: Bronchopneumonia; empyema, right; peritonitis purulent diffuse; nephritis, parenchymatous acute; fatty degeneration of liver; ulcerative endocarditis.

No. 31, 1917. Clinical Diagnosis: Measles; bronchopneumonia; bilateral; empyema, operated right.

Anatomical Diagnosis: Pneumonia, lobar right; infarcts, hemorrhagic left lung; empyema, localized right; endocarditis, ulcerative pulmonary valves; embolism and thrombosis of mesenteric vessels with diffuse hemorrhage into mesentery and omentum.

No. 36, 1917. Clinical Diagnosis: Measles; pneumonia, lower left and lower right; empyema, operated right.

Anatomical Diagnosis: Pneumonia, lobar left; empyema, right; endocarditis, vegetative mitral and aortic valves; nephritis, diffuse subacute.

No. 37, 1917. Clinical Diagnosis: Measles; bronchopneumonia, bilateral; empyema, operated right.

Anatomical Diagnosis: Pleuritis, fibrinous right; retraction and edema of right lung; nephritis, parenchymatous subacute; fatty degeneration of liver.

No. 4, 1918. Clinical Diagnosis: Measles; pneumonia, lobar right; empyema, operated left.

Anatomical Diagnosis: Pneumonia, lobar of upper and middle lobes right; empyema, bilateral.

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[13] In these necropsy abstracts the sequence of clinical diagnoses preceding the empyema is given. This sequence may not correspond with the findings at necropsy because of the long interval in some instances between operation and death.

No. 6, 1918. Clinical Diagnosis: Measles; pneumonia, lobar left; empyema, operated left.

Anatomical Diagnosis: Empyema, bilateral; pericarditis, purulent acute; nephritis, parenchymatous acute.

No. 8, 1918. Clinical Diagnosis: Pneumonia, broncho, bilateral; empyema, operated right with probable extension to left.

Anatomical Diagnosis: Pneumonia, lobar right and lower lobe left; empyema, right; pericarditis, acute (early).

No. 9, 1918. Clinical Diagnosis: Measles; pneumonia, broncho, bilateral; empyema, operated left.

Anatomical Diagnosis: Empyema, left; pericarditis, purulent acute (200 c.c.); peritonitis, diffuse acute.

No. 10, 1918. Clinical Diagnosis: Measles; pneumonia, lobar right; empyema, operated right.

Anatomical Diagnosis: Pneumonia, lobar lower left; empyema, right; tuberculosis, fibroid, right lung with calcified and cheesy peribronchial glands.

No. 12, 1918. Clinical Diagnosis: Pneumonia, broncho, left; empyema, operated left.

Anatomical Diagnosis: Pneumonia, broncho, left (extensive), less marked in right lung; large abscess in lower lobe of left lung; empyema, left, well drained; edema of both lungs.

No. 13, 1918. Clinical Diagnosis: Pneumonia, lobar, left; empyema operated, left; empyema, right; erysipelas, facial; nephritis, acute.

Anatomical Diagnosis: Bronchopneumonia, right, with abscess of lower lobe; localized dry empyema, right; pleural thickening and adhesions following rib resection, left; nephritis, acute; septic spleen; hyperemia and edema of brain.

No. 14, 1918. Clinical Diagnosis: Measles; bronchopneumonia; empyema, operated right; probable pericarditis.

Anatomical Diagnosis: Pneumonia, broncho, bilateral; empyema bilateral; substernal pus pocket, left; pericarditis, purulent acute (1000 c.c.); peritonitis, acute (early).

No. 17, 1918. Clinical Diagnosis: Pneumonia, lobar, right; empyema, operated right.

Anatomical Diagnosis: Peritonitis, purulent, diffuse; empyema, right.

No. 18, 1918. Clinical Diagnosis: Pneumonia, lobar lower left and right; empyema, operated right.

Anatomical Diagnosis: Carnification of right lung with interstitial changes; thickening of right pleura; nephritis, parenchymatous acute.

No. 20, 1918. Clinical Diagnosis: Measles; pneumonia, lobar (early), right; empyema, operated left.

Anatomical Diagnosis: Pneumonia, lobar, lower right (early); empyema, left with retraction of lung; thickened pleura and pleural pus pockets; pericarditis, purulent acute; nephritis, parenchymatous acute.

No. 24, 1918. Clinical Diagnosis: Pneumonia, lobar, lower left; empyema, operated left; arthritis, acute.

Anatomical Diagnosis: Pneumonia, lobar, lower left, and entire right lung; empyema, bilateral, with drainage of left; substernal pus pocket, right; parenchymatous degeneration, acute, of kidneys.

No. 25, 1918. Clinical Diagnosis: Measles, pneumonia, lobar right; empyema, operated right; probable pericarditis.

Anatomical Diagnosis: Pneumonia, unresolved, right lung with abscess in upper lobe; empyema, right; substernal pus pocket, right; parenchymatous degeneration, acute, of liver and kidneys.

No. 26, 1918. Clinical Diagnosis: Pneumonia, lobar, left and right lower; empyema, operated left; peritonitis.

Anatomical Diagnosis: Pneumonia, lobar, left; compensatory emphysema of right lung; empyema, left; pleuritis, fibrinopurulent, lining entire anterior and lateral surfaces of left chest and lung; septic spleen.

No. 33, 1918. Clinical Diagnosis: Measles; pneumonia, broncho, right; empyema, operated, right; toxic myocarditis.

Anatomical Diagnosis: Retraction and carnification of right lung; empyema, right; substernal pus pocket, right; peritonitis, acute, diffuse with perihepatitis and perisplenitis.

No. 39, 1918. Clinical Diagnosis: Pneumonia, lobar, left; empyema, bilateral (operated right); peritonitis.

Anatomical Diagnosis: Pneumonia, lobar, left; empyema, bilateral; walled-off pus pockets, left, anterolateral chest wall between upper and middle lobes of right lung and between pericardium and sternum on right; peritonitis, acute, diffuse; parenchymatous degeneration, acute, of kidneys, liver and spleen.

No. 44a, 1918. Clinical Diagnosis: Pneumonia, right and left; empyema, operated, left; probable peritonitis, mitral regurgitation.

Anatomical Diagnosis: Empyema, left; substernal pus pocket; retraction of left lung; pleural effusion (400 c.c.), right, with edema of lung; pericarditis, purulent chronic, with erosion of heart muscle and fibrous thickening of tissue in region of auriculoventricular bundle; ascites (700 c.c.).

No. 57, 1918. Clinical Diagnosis: Measles; bronchopneumonia, right; empyema, operated, right; intrapleural hemorrhage; probable necrosis and gangrene of right lung.

Anatomical Diagnosis: Empyema, right; collapse of right lung with necrotic areas and intrapleural hemorrhage.

No. 61, 1918. Clinical Diagnosis: Measles; pneumonia, lobar, right; empyema, operated right; bronchopleural communication right.

Anatomical Diagnosis: Empyema, healed right; tuberculous nodules in lungs, spleen, liver, kidneys, pleura and peritoneal surface of diaphragm; nephritis, parenchymatous acute; edema of brain.

SECOND SERIES EMPYEMA, NECROPSY ABSTRACTS.

No. 67, 1918. Clinical Diagnosis: Pneumonia, lobar, right lower and entire left; empyema, bilateral (operated left); nephritis, acute.

Anatomical Diagnosis: Empyema, left; peritonitis, acute diffuse; nephritis, parenchymatous acute.

No. 72, 1918. Clinical Diagnosis: Pneumonia, broncho, bilateral; empyema, bilateral (operated right); probable phlebitis left saphenous vein; pleuropericarditis; probable peritonitis and substernal pus pocket (right); septic arthritis, left hip and left elbow.

Anatomical Diagnosis: Empyema, bilateral; thrombosis of saphenous vein (left); pyemia with involvement of left elbow and abscess below left clavicle; substernal pus pocket, right.

No. 118, 1918. Clinical Diagnosis: Pneumonia, lobar, left, followed by empyema, operated, left; substernal pus pocket, right; pneumonia, broncho, right; peritonitis; possible pericarditis, purulent acute; nephritis parenchymatous acute.

Anatomical Diagnosis: Atelectasis and edema of left lung; walled-off empyema, left; early pneumonia of lower lobe, right; peritonitis, suppurative acute; nephritis, subacute, in slightly contracted kidneys; sacral decubitus; fatty degeneration of myocardium and liver; hyperplasia of spleen.

No. 130, 1918. Clinical Diagnosis: Empyema, operated, left; pyopneumothorax, right; pericarditis, plastic acute.

Anatomical Diagnosis: Empyema, left; substernal pus pockets, bilateral (100 c.c. pus in each); empyema, right (600 c.c.); pneumonic consolidation of upper lobe of right lung with multiple abscesses; atelectasis of lower lobe, right; pericarditis, fibrinopurulent early acute; marked parenchymatous nephritis and myocarditis.

No. 139, 1918. Clinical Diagnosis: Pneumonia, lobar, right; empyema, operated, right; pericarditis, plastic acute; pleuritis, plastic left.

Anatomical Diagnosis: Empyema, right; pleuritis obliterative, right; pleuritis fibrinous, left; pericarditis, serofibrinous acute (shaggy heart); degeneration, fatty, of myocardium.

No. 161, 1918. Clinical Diagnosis: Pneumonia, lobar, resolved, right; empyema, operated, right; pericarditis, purulent; peritonitis, purulent, diffuse; nephritis, parenchymatous; probable subdiaphragmatic abscess; toxic myocarditis.

Anatomical Diagnosis: Empyema, right, walled-off, free from pus; empyema, left (500 c.c.); atelectasis of left lung; peritonitis, fibrinopurulent, acute diffuse; acute toxic splenitis and nephritis (large white kidney); hydropericardium (200 c.c.).

No. 167, 1918. Clinical Diagnosis: Measles; pneumonia, broncho, left; empyema, operated, left; empyema, right; pneumonic infiltration of lower lobe of right lung; possible pericarditis and peritonitis.

Anatomical Diagnosis: Empyema, operated, left; empyema, right, 300 c.c. in three large pockets; peritonitis, fibrinopurulent, diffuse; atelectasis, partial, both lungs; hyperplasia with multiple infarcts of spleen; marked toxic nephritis and myocarditis.

No. 180, 1918. Clinical Diagnosis: Pneumonia, lobar, left; empyema, operated, left; peritonitis.

Anatomical Diagnosis: Empyema, left empty and nearly healed; complete atelectasis of left lung; obliterative pleuritis, left; peritonitis, suppurative, diffuse acute; pleuritis, fibrinopurulent, early acute, right; hypostatic congestion and edema of lungs; nephritis, parenchymatous acute; hyperplasia of spleen; degeneration, fatty of liver; cloudy swelling and fatty degeneration of myocardium.

No. 187, 1918. Clinical Diagnosis: Tonsillitis, follicular, acute; pleurisy, fibrinous, acute, right; empyema, operated, right; parenchymatous nephritis.

Anatomical Diagnosis: Empyema, right; pleuritis, fibrous, obliterative, right; atelectasis of middle and lower lobes of right lung; nephritis, parenchymatous chronic (large red kidneys); hypertrophy and dilatation of heart with marked fatty degeneration of myocardium.

No. 193, 1918. Clinical Diagnosis: Scarlet fever; pneumonia, lobar, left; pyopneumothorax, operated, left; pneumonia, lobar, right; nephritis, parenchymatous chronic; toxic myocarditis.

Anatomical Diagnosis: Empyema, left, drained empty; pleuritis, fibrous, chronic left and right; atelectasis, complete, left lung; nephritis, parenchymatous chronic with acute exacerbation; multiple minute petechial hemorrhages of all serous surfaces; edema of mesentery and retroperitoneal tissues; degeneration, fatty, marked, of myocardium; fibrous perisplenitis and localized peritonitis; congestion, chronic, passive, of liver.

No. 194, 1918. Clinical Diagnosis: Pneumonia, lobar, left; empyema, operated, left; nephritis, parenchymatous; myocarditis, toxic.

Anatomical Diagnosis: Pneumonia, unresolved, of entire left lung with abscess formation; empyema, left, empty; pleuritis, fibrous, left; nephritis, parenchymatous chronic, with acute exacerbation; degeneration, fatty, with toxic softening of myocardium; degeneration, fatty, with passive congestion of liver; hyperplasia, chronic, with passive congestion and pericapsular fibrosis of spleen; edema of retroperitoneal tissues.

No. 195, 1918. Clinical Diagnosis: Scarlet fever; pneumonia, lobar, right; empyema, operated, right; myocarditis, toxic; nephritis, parenchymatous, chronic.

Anatomical Diagnosis: Healing, empyema, right; pleuritis, fibrous, right; atelectasis and atrophy of right lung; nephritis, parenchymatous, chronic; marked toxic softening and fatty degeneration of myocardium with hypertrophy and dilatation; chronic hyperplasia of spleen; degeneration, fatty, of liver; cholelithiasis

No. 200, 1918. Clinical Diagnosis: Pneumonia, lobar, left; nephritis, parenchymatous (scarlet fever); empyema, operated, left; valvular heart disease (mitral regurgitation).

Anatomical Diagnosis: Tuberculosis, fibrocaseous miliary, of left lung; pleuritis, obliterative fibrous and tuberculous left; empyema, left, empty; pleuritis, serous, right (300 c.c.); nephritis, parenchymatous, chronic; degeneration, fatty, with toxic softening and dilatation of heart; edema and passive congestion of omentum, mesentery and retroperitoneal tissue with hemorrhage into small bowel and into stomach (slight).

No. 218, 1918. Clinical Diagnosis: Pneumonia, lobar, right lower; empyema, operated right; nephritis parenchymatous, acute.[14]

Anatomical Diagnosis: Atelectasis complete, right lung; edema of left lung; old fibrous pleurisy over external surface of right lung; subcutaneous ecchymoses over right side of body; subserous ecchymoses of pericardium, left pleura and peritoneum; serohemorrhagic effusions in the pericardial and left pleural cavities (700 c.c.).

THIRD SERIES EMPYEMA, NECROPSY ABSTRACTS.

No. 279, 1918. Clinical Diagnosis: Pneumonia, lobar, left; empyema, operated, left; probable pericarditis, purulent acute.

Anatomical Diagnosis: Pneumonia, lobar, left, with collapse of lung; empyema, drainage, left; pericarditis, seropurulent acute (1000 c.c.); emphysema of cellular tissue in anterior mediastinum; nephritis, parenchymatous acute, on chronic, left; nephritis, parenchymatous acute, right.

Bacteriological Findings: Left lung (blood-agar), pneumococci; heart's blood (broth), pneumococci; pericardial fluid (broth), pneumococci; pus from kidney, pneumococci.

No. 282, 1918. Clinical Diagnosis: Pneumonia, lobar, bilateral; empyema, bilateral (operated left).

Anatomical Diagnosis: Pneumonia, lobar, left and lower lobe of right lung; pneumonia, broncho, upper and middle lobes of right lung; empyema, left, with collapse of lung and pleuritis, fibrinopurulent acute; nephritis, parenchymatous acute; peritonitis adhesive, chronic; venous congestion, fatty degeneration and cloudy swelling of liver.

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[14] This patient died with clinical manifestations of uremia due to almost complete suppression of urine for three days before death. No mention was made of nephritis in the anatomic diagnosis but the kidneys were described in the necropsy report as follows: "The kidneys are not enlarged, the capsule comes away leaving a smooth surface which is pale and has a somewhat yellowish cast on section. The cortex is not enlarged and has homogeneous pinkish yellow color. Malpighian bodies are not well seen."

Bacteriological Findings: Pleural fluid, Streptococcus hemolyticus; pericardial fluid, Streptococcus hemolyticus.

No. 284, 1918. Clinical Diagnosis: Pneumonia, lobar, lower, left; empyema operated, left.

Anatomical Diagnosis: Empyema, left, with adhesive pleuritis, diaphragmatic bilateral; edema of lungs, bilateral; bronchitis and bronchiolitis purulent, left; cloudy swelling of liver and kidneys; nephritis, parenchymatous chronic, slight, of right kidney.

Bacteriological Findings: Lung (broth), pneumococcus; pleural fluid, pneumococcus and Streptococcus hemolyticus.

No. 294, 1918. Clinical Diagnosis: Influenza; pneumonia, lobar, bilateral; empyema, operated, left; empyema, right; pericarditis, fibrinous, acute.

Anatomical Diagnosis: Pneumonia, lobar, of entire right lung, lower lobe of left lung, lower margin of upper lobe of left lung; empyema, drainage, left; pleuritis fibrinoplastic and purulent bilateral; pericarditis fibrinoplastic and purulent; nephritis, parenchymatous, acute.

Bacteriological Findings: Pericardial fluid (blood-agar), pneumococcus; pericardial fluid (broth), pneumococcus; lung (blood-agar), pneumococcus; pleural exudate (broth), pneumococcus; pleural exudate (blood-agar), pneumococcus; heart's blood (broth), pneumococcus; heart's blood (blood-agar), pneumococcus.

No. 297, 1918. Clinical Diagnosis: Influenza; measles; bronchopneumonia; empyema, operated, left; nephritis, parenchymatous, acute.

Anatomical Diagnosis: Pneumonia, lobar, of lower left and middle and lower right; pneumonia, broncho, of upper left and upper right; purulent bronchitis; empyema, left; nephritis, parenchymatous, acute; cloudy swelling and fatty changes in liver; septic spleen.

Bacteriological Findings: Heart's blood, pneumococcus; lung, pneumococcus.

No. 298, 1918. Clinical Diagnosis: Pneumonia, lobar, lower left and middle and upper right; empyema, operated, left.

Anatomical Diagnosis: Pneumonia, broncho, lower right; pneumonia, lobar, upper right and entire left lung; empyema, left; pericarditis, fibrinopurulent, acute (500 c.c.); nephritis, parenchymatous, chronic.

Bacteriological Findings: Heart's blood, pneumococcus; lung, pneumococcus.

No. 12, 1919. Clinical Diagnosis: Influenza; pneumonia, broncho; empyema, operated, left; meningitis, acute (Streptococcus hemolyticus).

Anatomical Diagnosis: Empyema, left, practically healed; pleuritis obliterative, left; meningitis, basilar, fibrinoplastic and purulent; leptomeningitis of entire surface of cerebrum; empyema of all ventricles of brain.

Bacteriological Findings: Meningeal exudate, lateral ventricles, Streptococcus hemolyticus; spinal fluid cultures, Streptococcus hemolyticus.

COMPLICATIONS SUBSEQUENT TO OPERATION.

The complications subsequent to operation as disclosed at necropsy in these forty-eight patients are given in Table 24.

TABLE XXIV.

	First series, necropsies, 27. Per cent.	Second series, necropsies, 14. Per cent.	Third series, necropsies, 7. Per cent.
Nephritis	40.7	85.7	85.7
Pericarditis	29.6	21.4	57.1
Peritonitis	25.9	42.8	14.2
Substernal pus pockets	18.5	14.3	0.0
Lung abscess	18.5	14.3	0.0
Empyema bilateral	22.2	28.6	14.2
Endocarditis	14.8	0.0	0.0
Meningitis (metastatic)	0.0	0.0	14.2
Pneumonia of both sides	25.9	28.5	57.1

In Table 25 is given the findings in 100 patients, with empyema, who came to necropsy without operation between November, 1917, and January 25, 1919. Many of these patients died while the pneumonic process was active and were not considered suitable risks for any kind of operation except aspiration.

TABLE XXV.—NECROPSY FINDINGS IN ONE HUNDRED EMPYEMA PATIENTS UPON WHOM OPERATION WAS NOT PERFORMED.

	Per cent.
Nephritis, parenchymatous acute diffuse or exacerbation of chronic	47
Pericarditis, serofibrinous or purulent	46
Pneumonia active in both lungs	45
Empyema, bilateral	19
Abscess of lung	15
Peritonitis, metastatic diffuse purulent	13
Substernal pus pockets	11
Endocarditis, ulcerative or vegetative acute	3
Tuberculosis, pulmonary active	3
Meningitis, subacute basilar	3

Nephritis. In 85.7 per cent. of 21 patients who died subsequent to the operations of the second and third series, nephritis was found at necropsy. In a considerable number of these patients scarlet fever had immediately preceded the pneumonia and empyema. The nephritis was usually of the acute parenchymatous or diffuse form. In a few an acute exacerbation of a chronic diffuse nephritis had occurred. Pneumonia with empyema following scarlet fever carried with it a much more serious prognosis than pneumonia and empyema without this immediately preceding acute disease. The urinary output and analysis should be carefully watched in every empyema patient. The acute sepsis has not produced either in the 48 necropsies upon patients who had been operated for empyema or in the 100 necropsies upon patients who died without operation the picture of amyloid kidney in any case. Bilateral empyema was present in 30 per cent. of 23 instances of nephritis in the operated patients of the first and second series.

Pericarditis. Pericarditis, seropurulent or purulent, occurred in 36 per cent. of 48 patients who came to necropsy subsequent to empyema operations. It occurred in 46 per cent. of 100 patients with non-operated empyema who came to necrospy. In many patients the occurrence of a to-and-fro pericardial friction rub could be detected prior to the widened area of heart dulness and the more distant heart tones due to effusion. Such an occurrence was of serious prognostic significance in a patient with empyema (Fig. 1).

The diagnosis of purulent pericarditis is attended with great difficulty. I have repeatedly seen at necropsy the normal amount of pericardial fluid replaced with thin fibrinopurulent fluid, or, if the process had existed for twelve to fourteen days, as judged by the clinical history, fibrin organization had taken place, with firm enveloping adhesions, between the pericardium and myocardium and the typical picture of the so-called "shaggy heart." In many such patients the area of heart dulness was not increased either by percussion or the roentgenogram, since distention of the pericardium had not taken place. There had merely been a change from a serous to a fibrinopurulent fluid in the pericardium. Any earlier friction rub which may have been transitory was with difficulty differentiated from a pleuropericardial rub in a patient with rapid respirations, due to pneumonia, an empyema or a pneumothorax. The distant heart tones present in hydropericardium could not be relied upon in the diagnosis of those instances of purulent pericarditis in which the fluid was not greatly increased in amount. A left-sided closed pneumothorax also so muffled the heart tones in numerous instances as to lead to a suspicion of pericarditis, with effusion, when such a condition did not exist.

Paracentesis of the pericardium for the relief of effusion, if carefully performed, involves little risk. It should be mentioned, however, that in only one patient was the procedure of any avail in contributing to recovery. In diagnostic and prognostic importance the procedure was of value.

In the 27 necropsies which followed the first series of empyema operations, 4 instances of pericarditis followed an empyema of the left side, 3 followed empyema of the right side, while in 1 the empyema was bilateral.

In the 14 necropsies which followed the second series of empyema operations, 1 instance of pericarditis followed empyema of the right side while in 2 instances the empyema was bilateral.

In the 7 necropsies which followed the third series of empyema operations, 3 instances followed empyema of the left side while in 1 instance the empyema was bilateral. To recapitulate, in 15 patients, pericarditis, usually purulent, developed in 7 instances when the empyema was on the left side, in 4 instances when the empyema was on the right side and in 4 instances when the empyema was bilateral. The occurrence of pericarditis bears an undoubted relationship to the presence of substernal pus pockets (*vide infra*).

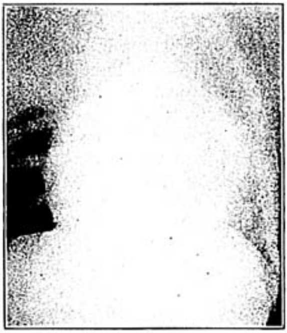

FIG. 1.—Encapsulated empyema, left, with pericardial effusion. Oper. Series II, No. 3. Recovery.

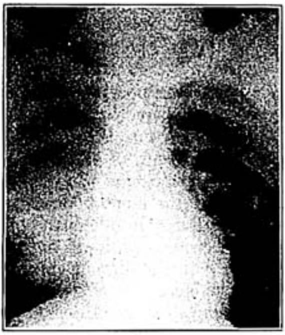

FIG. 2.—Abscess of lung, right, with bronchial drainage. Probable tuberculosis, left. Recovery.

Substernal Pus Pockets. The occurrence of this serious complication apparently varied with the type of pneumonia. It was more commonly noted subsequent to the type of interstitial pneumonia which followed measles and the empyemas constituting the first series of operations (18.5 per cent. of 27 necropsies). It also was encountered in 14.3 per cent. of the instances of empyema necropsies of the second series, which likewise occurred subsequent to an epidemic of streptococcus pneumonia, in which many interstitial types of pneumonia were encountered. In the third series of empyema necropsies (following influenzal pneumonia) this complication was not encountered and but few instances of the interstitial types of pneumonia occurred. Substernal pus pockets appeared to be an infrequent complication except in the interstitial types of streptococcus pneumonia. We[15] have believed that the spread of the infection to this locality occurred by way of the lymphatic channels of the parietal pleura to the chain of substernal lymph nodes immediately beneath the sternum and which were not directly connected with the anterior mediastinum. The situation of these pus pockets apparently made infection of the pericardium more liable to occur by contiguity.

Peritonitis. Peritonitis, serofibrinous or purulent diffuse, occurred in 14 of the 48 necropsies (29.2 per cent.), constituting the patients with operated empyema in the three series; in 5 the empyema was bilateral, in 5 the empyema occurred on the left side, while in 4 the empyema occurred on the right side. Extension had occurred through the diaphragm in all but 1 of the cases. In 1 patient a postoperative pneumonia and empyema followed appendectomy, with peritonitis. In but 1 instance did verified peritonitis occur without empyema.

Bilateral Empyema. Bilateral empyema was found in 11, or 22.9 per cent., of 48 patients who came to necropsy in the three series of empyema operations. In the majority of patients in which this occurred there had been pneumonia affecting both lungs.

Bilateral Pneumonia. Bilateral pneumonia was found in 15, or 31.2 per cent., of 48 patients who came to necropsy in the three series of empyema operations. In a considerable additional number of cases the lung on the opposite side was collapsed or markedly edematous. In others an obliterative fibrous pleuritis was present on the side opposite to the operated empyema. This had occurred as a sequel to fibrinous pleuritis accompanying the earlier bilateral pneumonia.

Lung Abscess. Abscess of the lung was found in 7, or 14.6 per cent., of 48 patients upon whom necropsy was performed in the three series of empyema operations. In 5, or 71.4 per cent., of these the abscesses were multiple and occurred on the affected side. Necrosis of lung sufficient to produce considerable intrapleural hemorrhage occurred in one patient (Fig. 2).

Other Complications. Less frequent conditions found at necropsy in the three series of empyema operations were tuberculosis, pulmonary fibrocaseous or miliary; metastatic meningitis; endocarditis; hydropericardium; embolism and thrombosis of mesenteric vessels; myocardial degeneration. The myocardial softening differed in no essential particular from that degree of parenchymatous degeneration affecting all organs in the presence of a chronic septic process. Ascites as a result of myocardial degeneration and nephritis occurred in one instance.

DIAGNOSIS. A pleural effusion or empyema should be suspected in every pneumonia patient whose respiration early in the disease shows embarrassment, especially if associated with a pleural friction rub and pulse-rate out of relative proportion to the fever. The occurrence of severe pleural pain with an expiratory grunt was always suggestive of pleural effusion twenty-four hours later. The aspirating needle should be used early, the points selected being over the areas of greatest dulness. Care should be exercised in the cautious insertion of the needle to avoid pneumothorax from puncture of the lungs (manifested usually by bright blood upon aspiration). The danger of a closed pneumothorax accidentally produced in this manner has probably been overestimated, but its occurrence should, of course, be avoided if possible. The glass syringe should be preferably attached to the needle by a short (two-inch) connection of rubber tubing with fairly heavy wall. In case it was necessary to disconnect the syringe during aspiration, following an exploratory puncture, the rubber tubing was clamped to prevent entrance of air. The physical signs of fluid in many instances were untrustworthy. More distant breath sounds replacing the close-to-the-ear tubular breathing, the abolition of whispered voice transmission, decreased vocal and tactile fremitus and respiratory lagging of the affected side were the essential physical signs. Dulness on percussion was the most important single sign. With quantities of fluid up to 200 c.c., vocal or tactile fremitus and the transmission of whispered voice might still occur if a portion of consolidated lung occupied a position between the fluid and the chest wall. In bilateral empyema, as in acute emphysema, the type of breathing was abdominal rather than costal.

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[15] Stone, W. J., Phillips, B. G., and Bliss, W. P.: Arch. Int. Med., 1918, xxii, 409.

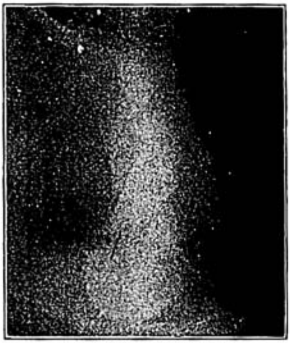

FIG. 3.—Resolving pneumonia on right side, with walled-off fluid in outer portion. Note the high diaphragm. Oper. Series III, No. 55. Recovery.

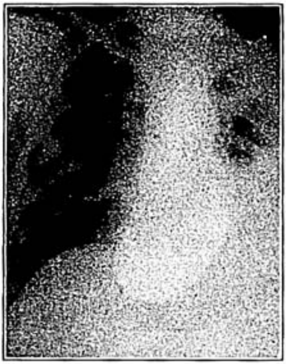

FIG. 4.—Resolving pneumonia, right. Thickened pleura, resolving pneumonia and fluid at base, left.

In performing paracentesis it was found wise to remember that the diaphragm may be higher than normal on the affected side, due to pleural adhesions. Roentgenograms of the chest were of great help in localizing small accumulations of fluid, interlobar empyema or pockets of pus in unusual locations, such as near the apex of the lung. The roentgenogram was of little help in the diagnosis of substernal pus pockets. Greater dependence should always be placed upon the history of the clinical course, the physical signs and the aspirating needle. So-called unresolved pneumonia does occasionally occur as a cause of delayed convalescence. When it does occur the cause is usually to be found in a localized empyema. Empyema of the pleural cavity developed very rapidly in certain types of pneumonia in which a hemolytic streptococcus was present as an associated infection. This was especially true of the pneumonia following measles, scarlet fever and influenza. The question was very frequently raised in our minds as to the occurrence of a primary pleuritis in these patients. Cyanosis in such patients was usually an early feature. The pathological process was so extensive, the exudation so rapid, as a result of the widespread fibrinous pleuritis, that little could be done, except repeated aspirations, for these unfortunate patients.

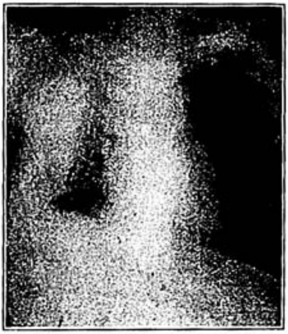

FIG. 5.—Walled-off empyema, right, anterolateral portion of chest. Note the high diaphragm.

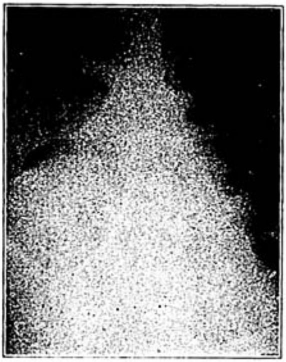

FIG. 6.—Empyema, right, pleural cavity, extending to height of third rib in front. Oper. Series II, No. 38.

Later in the course of what has many times appeared to be an uncomplicated pneumonia, if the fever persisted, the pulse-rate elevated and the respirations were increased an encapsulated empyema was located. If one recalled to mind the five most common complications as a cause of death in pneumonia which had progressed beyond the acute stage, diagnosis of the cause of death was much facilitated. These were:

1. Empyema with possible peritonitis.
2. Spread of pneumonia to the opposite side.
3. Pericarditis, serofibrinous or purulent.
4. Nephritis.
5. Substernal pus pockets (in the interstitial types of streptococcic pneumonia following measles and scarlet fever) and lung abscess.

TREATMENT. In performing the repeated aspirations one may expect the fever, pulse-rate and many times the respiratory embarrassment to diminish. We have been guided by four points in deciding upon the proper time for operation in a unilateral empyema: (1) the quantity and character of the pus; (2) the type of infection; (3) the presence or absence of complications; (4) the length of time necessary to show improvement in the general condition of the patient under the aspirations. It will be noticed in Table 15 that an average of six aspirations were performed and that the average was about nineteen days before operation for the patients of the second series. In Table 21 it will be noticed that the average number of aspirations was 3.7 and that the interval before operation was 13.5 days for the patients of the third series. In individual patients the average length of time before operation in the second series was longer than may have been necessary. It is probable that the high mortality of the first series had made us unduly conservative.

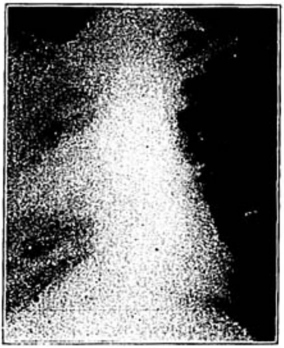

FIG. 7.—Resolving pneumonia, with opaque area, due to interlobar empyema, right side.

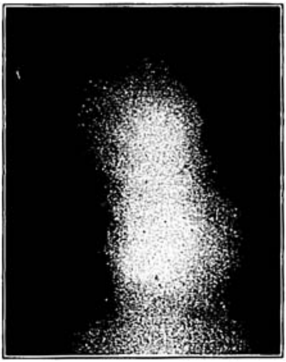

FIG. 8.—Localized empyema of right apex.

The time for operation will in general depend upon the four factors mentioned above. Five aspirations during a period of twelve to fourteen days, if the patient has shown improvement, will constitute an average. Operation may, with greater safety, be longer postponed upon a patient with pneumococcus than streptococcus infection. The older teaching that a pneumococcus empyema would recover by aspiration should be revised. In the 35 patients who recovered by aspiration alone a pneumococcus empyema was present in 9, or 25.7 per cent. One of the patients who recovered without operation had bilateral empyema due to pneumococcus infection. A total of nineteen aspirations were performed upon him, with recovery; 35, or 11.3 per cent., of the 310 patients here reported, recovered without operation. This closely corresponds with the figures from Camp Lee (13 per cent.) mentioned by Major Graham and Captain Bell.[16] It is probable that our records of the aspirated recoveries are incomplete, since many patients recovered from whom pus was aspirated in small quantity upon one or two occasions, of whom no record of empyema was kept for the purpose of this study.

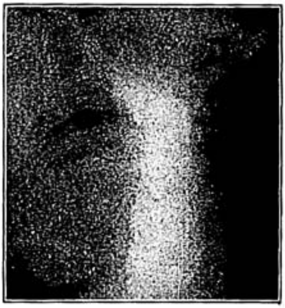

FIG. 9.—Encapsulated empyema, right, ten days after drainage operation. Oper. Series III, No. 53. Recovery.

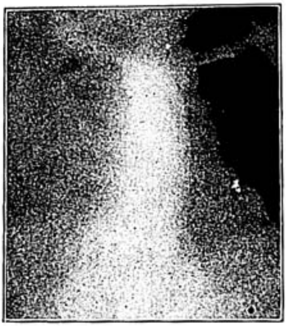

FIG. 10.—Empyema, right, with displacement of heart to left. Note shadow in median line, due to probable substernal pus pocket. Oper. Series III, No. 26. Recovery.

In performing the aspirations, when the pus was thick and because of some complication such as an active pneumonia on the opposite side or a bilateral empyema, operation did not at the time appear advisable, intrapleural lavage, using sterile saline solution, was performed at the time of aspirations in order to dilute the pus and permit of its aspiration. The apparatus consisted of a Potain aspirator, the rubber tubing from which connected with one arm of a three-way stopcock, to another arm of the stopcock was attached a portion of rubber tubing and the aspirating needle, while to the third arm was connected a portion of rubber tubing with a bottle containing the warm saline solution. Through the rubber cork of this bottle a glass connection was attached to a rubber bulb, pressure of which forced the saline solution from the bottle through the tubing. After the aspirating needle was inserted as much pus as could be aspirated flowed into the bottle. The stopcock was then turned so as to connect with the bottle containing the saline solution. By pressure on the bulb, saline solution in quantities of 200 to 300 c.c. was forced through the aspirating needle into the chest cavity. The stopcock was again turned and the diluted pus aspirated into the vacuum bottle. In this manner quantities of pus varying in amounts from 400 to 800 c.c. could be removed in excess of the amount secured by the first aspiration and in excess of the amount of saline solution introduced.

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[16] AM. JOUR. MED. SC., 1918, clvi, 839.

At the time of operation the patient received hypodermically one-eighth grain of morphin and one-two-hundredth grain of hyoscin one hour before going to the operating room. This was repeated one-half hour before the operation, except in markedly weakened patients. General ether anesthesia has been proved safe for these patients in the absence of an active pneumonic process and upon whom a number of aspirations have been performed. This was especially true if after the ether anesthetic the lungs were thoroughly ventilated of ether vapor by oxygen inhalation with the closed cone for about five minutes. Recovery from the anesthetic occurred rapidly and no ill effects from the ether were evident subsequently. Except for a few of the patients in the first series, empyema cases have remained in special wards of the pneumonia sections under the care of the medical service. They have been operated, by a surgeon assigned for this duty, by the chief of the surgical service, in special operating rooms of the pneumonia sections, which rooms were also used for the daily dressings. The aspirations were performed by the medical officers who cared for the patients during their attack of pneumonia. Since the causes of death subsequent to operation were those resulting from medical complications, the patients remained under the care of the officers of the medical service who had been familiar with the course of the illness from the time of its onset.

The attempt was made at the time of operation to secure copious drainage for the first forty-eight hours by means of a single large drainage tube (about four inches long and three-quarter-inch inside diameter), after which, in many patients, the modified Brewer tube, with Ewald suction bulb and Carrell tube for irrigation, shown in Fig. 11, was inserted. The skin opening should not be much longer (about two inches) than the width of the flange on the Brewer tube. While this small incision made it more difficult for the operator to resect one-inch of rib, it was possible to fit the Brewer tube tighter and better negative pressure by the suction of the Ewald bulb could be secured. At the present time no irrigation is used for the first forty-eight hours. At the end of that period irrigation is carried out by means of the apparatus as shown in Fig. 12. Neutral solution of chlorinated soda in quantities of 100 to 300 c.c., depending upon the size of the cavity, was allowed to flow in or was injected by means of a hand syringe, every two hours. Suction was secured at the end of two hours to remove the solution and pus before the fresh solution was placed in the cavity. At the end of the first week suction was more or less continuously employed and one daily irrigation in the dressing room substituted for the continuous irrigation in the wards. Pain contra-indicated suction. Irrigation with the neutral solution of chlorinated soda was contra-indicated if a communication with a bronchus was suspected. It has not been necessary to have any extensive secondary operation performed for

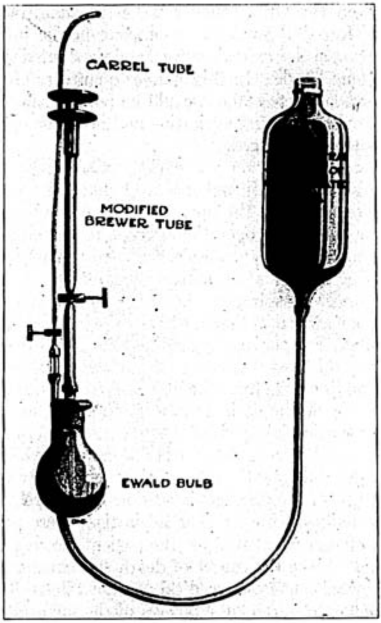

FIG. 11.—Apparatus for continuous or interrupted empyema irrigation and suction as used at U. S. Army Base Hospital, Fort Riley, Kansas.

large open pneumothorax or cavity in any of these patients, although sequestrectomy for a small portion of necrotic rib and dissection of the sinus was necessary in a few patients.

The daily irrigations were, as a rule, continued until pus was absent. The Brewer tube was removed after two weeks and gradually decreasing sizes of plain rubber tubing substituted for drainage purposes. The count of the number of bacterial cells per field from smears of the discharge as an index to the efficiency of the irrigation has given in our hands no more definite information as to the safe time for closure of these wounds than the clinical evidences. As the size of the opening of the pneumothorax diminished the lung was able to resume expansion. The ability of the lung on the affected side to expand determined to large degree the extent of drainage and the obliteration of the empyema cavity. Posture in bed and suction assisted drainage, but drainage was greatly facilitated if expansion of the lung could occur. The external opening should therefore be decreased in size as rapidly as possible by substituting smaller-sized tubes sufficiently large for drainage and irrigation.

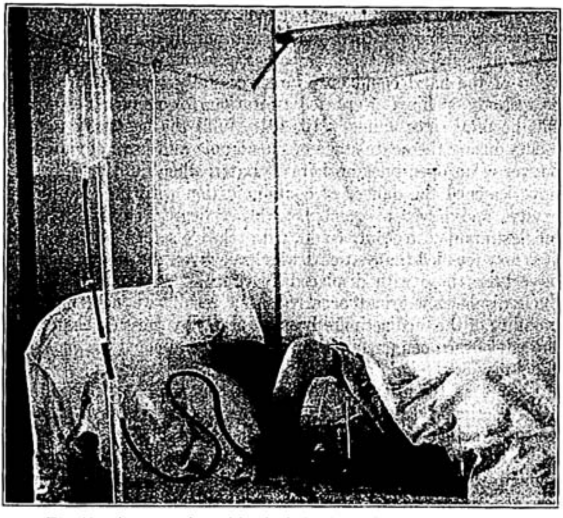

FIG. 12.—Apparatus in position for irrigation and suction in empyema.

The postoperative dressings required rigid surgical cleanliness to prevent secondary infection of the pleura, a condition particularly liable to occur. A high calorie diet was used to make up for the extensive tissue waste which accompanied the chronic sepsis. A diet of 3500 to 4000 calories could be readily secured by augmenting the regular or special diet with carbohydrates and fats.

Trocar drainage of empyema has not been satisfactory in our hands. If used during the course of an active pneumonia for the drainage of thin pus, danger of an open pneumothorax was constantly present if the patient was delirious, and, because of the pain caused by the presence of a metal tube, attempted its forcible removal. If used at a later stage, when the pus had become thickened, the lumen of the cannula was insufficient in size to drain the larger masses of fibrinous exudate so commonly present. The use of neutral solution of chlorinated soda as an irrigating fluid would in many cases liquefy these masses and permit drainage through a relatively small-sized tube. In other cases masses as large as the palm of the hand could only be successfully removed through a costectomy opening. Repeated aspirations for empyema as used in this hospital since January 12, 1918, fulfil the necessary requirements during the acute stage of pneumonia and have obviated the danger of an open pneumothorax. Later, when limiting adhesions have lessened the danger of communication with the free pleural cavity, and have, to greater or lesser degree, immobilized the mediastinum, costectomy could, with relative safety, be performed. It is now recalled that patients who have given the greatest anxiety have been those with displaced heart in an open pneumothorax. Such displacement had occurred as a result, we now know, of mobility of the mediastinum brought about by pressure changes on the side of the open pneumothorax which had affected the expansion capability of the lung on the opposite side.

Because of the interest attached to a comparison of clinical facts and experimental data, those who are interested should read the excellent article by Major Graham and Captain Bell (*loc. cit.*), in which it was shown experimentally that the pressure changes brought about by an open pneumothorax affected not only the lung on the side of the opening but affected in similar degree the opposite lung, due to the mobility of the mediastinal structures. As has been stated by them, the normal thorax may be considered as one cavity instead of two. They have expressed the belief that the dangers of an open pneumothorax are much lessened after adhesions have formed which immobilized the mediastinum. The formation of such adhesions has been favored by the late operation as well as more adequate air space in the lungs resulting from the subsidence of the pneumonia and decreased bronchial exudate.

The bearing of such facts upon the treatment of empyema is obvious, facts which, it is believed, have been verified clinically by the results secured for those patients, here reported, upon whom the late operation had been performed.

The average incapacity from empyema necessitating drainage will probably be not far from three months. Recovery has in some patients taken place in four to six weeks, but many other patients have required four to six months. Two or three of the patients in the first series had small costal sinuses after one year.

The writer has been under constant obligation to many officers who have earnestly coöperated in this work, especially to Major B. G. Phillips, Captains W. P. Bliss, W. S. Binford, W. M. Stout, C. W. Zugg and J. H. Armstrong, Lieutenants C. L. Morris, A. B. Schwartz, P. S. Murphy, C. S. Mundy, G. F. Zachritz, S. T. Nicholson, Jr., G. M. Purves, W. A. Meierding, H. A. Kirkham, C. L. McLaughlin and A. F. Watts; to Captain E. S. Cummings and Lieut. G. H. Cooper for roentgenographic assistance; to Major O. F. Broman, Captain R. L. Benson and Captain W. Levin of the Laboratory Staff, and to Captain H. W. Cattell, Lieutenants F. K. Bartlett and A. A. Smith for necropsy notes.

SCLERODERMA AND SCLERODACTYLY: REPORT OF A CASE, WITH ROENTGEN RAYS AND REVIEW OF THE LITERATURE.

By Reginald M. Atwater, M.D.,
BOSTON, MASSACHUSETTS.

(From the Medical Clinic of the Peter Bent Brigham Hospital, Boston.)

Cases of scleroderma and sclerodactyly, with roentgen-ray studies of the bony changes, are infrequent enough in the literature to justify the reporting of a case. The case here recorded is that of a Jewish woman, aged fifty years, who entered the medical wards of the Peter Bent Brigham Hospital on December 16, 1918 (Med. No. 10,081), complaining of stiffness of the joints, particularly in the hands, but also generally throughout the body.

The present illness has begun one year previously, with stiffness in the shoulders, which later appeared in the hands and arms and in turn in the back and legs. Four months previous to her entrance she had pain in the neck about the ear, most marked on the left side. She complained of particular difficulty on the left side of the whole body. There was considerable aching pain throughout the affected parts, which was worse at night. During the two weeks preceding entrance the pain had become much worse. Although she refers all the pain to the joints, her difficulty is best described as a general stiffness of the extremities themselves and not wholly as a joint affair. The onset of the thickening in each new spot is preceded by an itching, papular eruption, lasting several days.